MICHIGAN STATE UNIVERSITY

Class 9

F=ma | Newton’s third law

PHY 231
Fall 2004
Prof. S. Billinge

Announcements

MICHIGAN STATE UNIVERSITY

- Exam
- Homework due at 10:00pm tonight (only 4 questions this week)

PHY 231
Fall 2004
Prof. S. Billinge

Concepts overview

1. Newton's first law (objects in motion)
2. Newton's second law (F=ma)
3. Newton's third law (action = reaction)
4. Force due to Gravity (weight)

MICHIGAN STATE UNIVERSITY

PHY 231
Fall 2004
Prof. S. Billinge

Problem Solving Overview

- Rigid body diagrams

PHY 231
Fall 2004
Prof. S. Billinge

Newton's Laws (short version as memory aid):

1. Objects in motion stay in motion, unless acted on by a (net) force
2. **F**=m**a**
3. Action = Reaction

MICHIGAN STATE UNIVERSITY

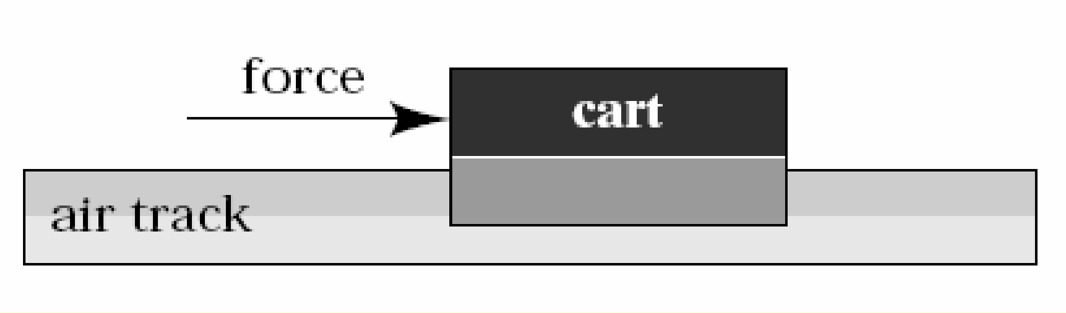
PHY 231
Fall 2004
Prof. S. Billinge

Notes

1. "Net force": the resultant force from doing a vector sum of all forces on an object
2. **F**=m**a**: **a** is the acceleration of the object in question, **F** is the *net force* on the object

PHY 231
Fall 2004
Prof. S. Billinge

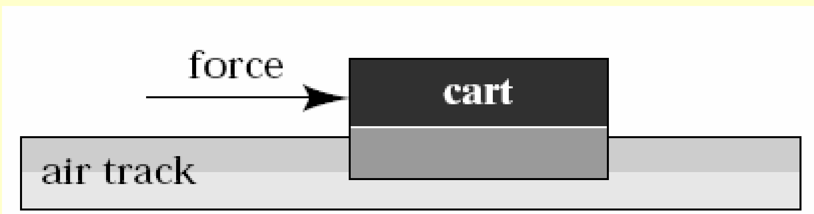
A constant force is exerted on a cart that is initially at rest on an air track. Friction between the cart and the track is negligible. The force acts for a short time interval and gives the cart a certain final speed. To reach the same final speed with a force that is only half as big, the force must be exerted on the cart for a time interval



1. four times as long as
2. twice as long as
3. equal to
4. half as long as
5. a quarter of

that for the stronger force.

A constant force is exerted for a short time interval on a cart that is initially at rest on an air track. This force gives the cart a certain final speed. The same force is exerted for the same length of time on another cart, also initially at rest, that has twice the mass of the first one.The final speed of the heavier cart is



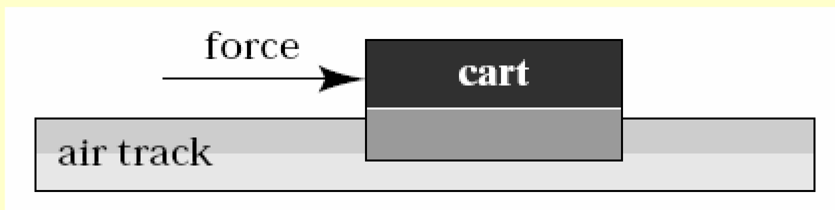
1. one-fourth
2. four times
3. half
4. double
5. the same as

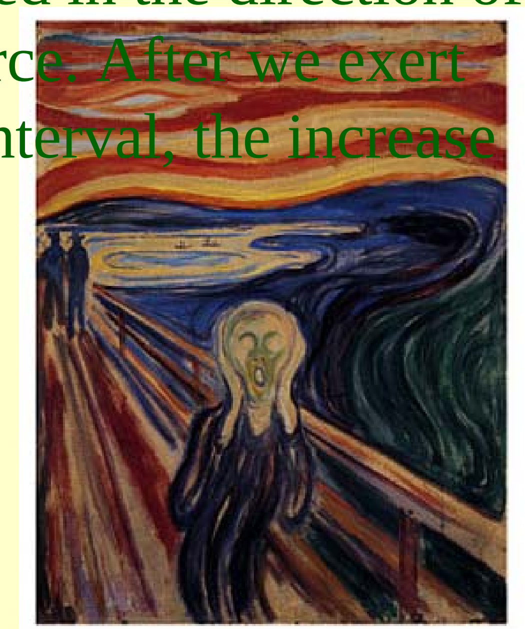
that of the lighter cart.

MICHIGAN STATE UNIVERSITY

PHY 231
Fall 2004
Prof. S. Billinge

A constant force is exerted for a short time interval on a cart that is initially at rest on an air track. This force gives the cart a certain final speed. Suppose we repeat the experiment but, instead of starting from rest, the cart is already moving with constant speed in the direction of the force at the moment we begin to apply the force. After we exert the same constant force for the same short time interval, the increase in the cart's speed





1. is equal to two times its initial speed.
2. is equal to the square of its initial speed.
3. is equal to four times its initial speed.
4. is the same as when it started from rest.
5. cannot be determined from the information provided.

PHY 231
Fall 2004
Prof. S. Billinge

Force due to gravity

The force due to gravity has a special name: the weight

Note: *weight* is different from *mass*

Weight is a FORCE (units N)

Mass is a mass (units kg)

Weight is a VECTOR (because force is a vector quantity)

Mass is a SCALAR quantity

$$\mathbf{W} = m\mathbf{g}$$

Weight always acts vertically downward

(towards the center of the earth)

PHY 231
Fall 2004
Prof. S. Billinge

MICHIGAN STATE UNIVERSITY

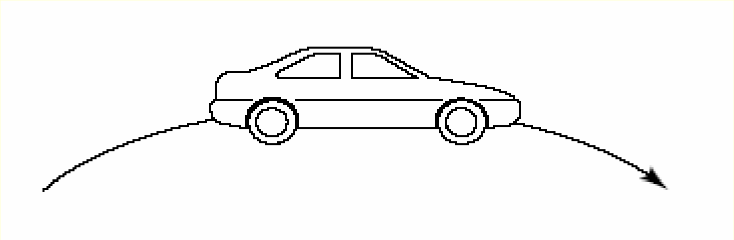
Consider a person standing in an elevator that is accelerating upward. The upward normal force *N* exerted by the elevator floor on the person is

1. larger than
2. identical to
3. smaller than

the downward weight *W* of the person.

PHY 231
Fall 2004
Prof. S. Billinge

A car rounds a curve while maintaining a constant speed. Is there a net force on the car as it rounds the curve?



1. No—its speed is constant.
2. Yes.
3. It depends on the sharpness of the curve and the speed of the car.

MICHIGAN STATE UNIVERSITY

PHY 231
Fall 2004
Prof. S. Billinge

In the 17th century, Otto von Güricke, a physicist in Magdeburg, fitted two hollow bronze hemispheres together and removed the air from the resulting sphere with a pump.Two eight-horse teams could not pull the halves apart even though the hemispheres fell apart when air was readmitted. Suppose von Güricke had tied both teams of horses to one side and bolted the other side to a heavy tree trunk. In this case, the tension on the hemispheres would be

1. twice
2. exactly the same as
3. Half

what it was before.

MICHIGAN STATE UNIVERSITY

PHY 231
Fall 2004
Prof. S. Billinge

Rigid Body problems

MICHIGAN STATE UNIVERSITY

1) Isolate the object you are interested in
2) Mark on **all** the forces
3) Mark on the acceleration
4) Find the components of the forces (usually parallel and perpendicular to the *acceleration* direction)
5) Apply F=ma in both directions

PHY 231
Fall 2004
Prof. S. Billinge

Force picker checklist

MICHIGAN STATE UNIVERSITY

Mark ***all*** forces…

Checklist:

1. Weight (= *mg* vertically downwards)
2. Normal force (perpendicular to the surface)
3. Tension force (along any rope)
4. Friction force (parallel to the surface)
5. Other contact forces

PHY 231
Fall 2004
Prof. S. Billinge